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This paper investigates whether the services of the Federal Reserve System improved the efficiency of the system in the United States for collecting checks relative to the efficiency of the system used by banks just prior to the formation of the Federal Reserve. There are two types of evidence that the Fed's services improved efficiency. First, the Reserve Banks quickly became major processors of interregional checks, even though banks could have continued to use the prior payments arrangements. Second, declines in the ratios of cash to total assets of banks can be attributed to the development of the Fed's check collection services.

Key words: Federal Reserve, payments system, efficiency.

Effects of the founding of the Federal Reserve System have received a great deal of attention in the economics literature. Economists have focused primarily on macroeconomic effects, like the rate of inflation, the frequency and severity of recessions and depressions, and seasonal patterns in interest rates.[1]

This paper examines the effects of the Fed's founding on the operation of the nation's system for collecting checks. Most of the historic writing on the Fed's check collection services focused on the failure of the Fed to impose the collection of checks at par as the national standard for the banking industry. The banks that refused to pay the Fed at par for checks drawn on the accounts of their

[1] See references in Miron (1986). Also see Mankiw, Miron and Weil (1987, 1990); and Fishe and Wohar (1990).

customers prevailed in a long legal battle.[2] Some banks continued to operate as nonpar banks until the early 1980s.

This paper uses a different standard in judging the success or failure of the Fed's involvement in the operation of the check collection system: the effects of the Fed's payment services on the efficiency of the check collection system. Analysis of efficiency focuses on the costs of banks in processing payments. In a more efficient payments system, banks are able to process the same payments at lower costs.

A broad assessment of the effects of Reserve Bank services on the efficiency of the payments system would deal with the following questions.

- Is there evidence to support the hypothesis that Reserve Bank services improved the operation of the payments system relative to the way the payments system functioned just prior to the formation of the Fed?
- If Congress wanted to improve the efficiency of the payments system in 1913, alternatives to government provision of payments services would have included nationwide branch banking and reform of the legal foundation for check clearing. Would these alternative approaches have improved the efficiency of the payments system more than authorization for the Reserve Banks to provide payment services?
- Over the years since its founding, has the Fed enhanced or retarded innovations that improve the efficiency of the payments system?
- Does the Fed still have a valid role as a provider of payment services in the current environment of nationwide branch banking?

This paper has a narrow focus, examining only the first of these questions. Evidence that Reserve Bank payment services improved the efficiency of the check collection system relative to its operation just prior to the formation of the Fed would not be sufficient for answering the other questions. Such evidence,

[2] For several sources, see Jones (1931), Spahr (1926), Tippetts (1929) and Vest (1940).

however, would answer an important question about the early impact of the founding of the Fed on the economy.[3]

The first section describes the payments system before Congress established the Fed. The following sections describe the legal foundation of the Fed's collection services and trace the development of Reserve Bank services. The theoretical section defines efficiency and indicates the nature of empirical observations that would be consistent with a positive effect of Reserve Bank collection services on payments system efficiency. The empirical section examines this evidence.

OPERATION OF THE U.S. PAYMENTS SYSTEM PRIOR TO 1914

This section focuses on the payments system in the United States from around 1850 until the formation of the Fed in 1914.[4]

Payment Instruments

To understand the operation of the U.S. payments system from the 1850s until 1914, it is necessary to distinguish between checks and drafts, which differ in terms of the party that created the payment instrument. Depositors at banks created checks, which they made payable to the order of payees in settlement of obligations. Banks wrote drafts. A bank might draw a draft upon itself or upon an account that it maintained at another bank. When making a

[3]. Lacker, Walker and Weinberg (1999)conclude the Reserve Bank services reduced the efficiency of the payments system.

[4] For a more detailed discussion of the U.S. payments system prior to the formation of the Fed, see Gilbert (1998).

payment in a distant city, a bank customer often purchased from its local bank a draft drawn on a bank in a major financial center.

A major change in the U.S. payments system occurred in the 1850s. Prior to the 1850s, the most important means of payment was currency. The dollar value of currency in the hands of the public exceeded the value of deposits, and the dollar value of payments settled using currency exceeded that settled using checks and drafts. After the 1850s, in contrast, checks and drafts became more important than currency: the dollar value of deposits exceeded that of currency, and the value of transactions settled using checks exceeded that settled using currency (Spahr, 1926, pp. 84-98).

Selling drafts was a source of revenue for banks, since customers paid banks more than the face amount of the drafts. The business of selling drafts involved the expense of maintaining balances with the banks in major financial centers. When drafts cleared, generally through clearing houses in the financial centers, the banks on which they were drawn would debit the accounts of the banks that sold the drafts. Banks often replenished their balances with banks in the financial centers through transactions in local markets for domestic exchange. Banks located in various communities established these markets for trading local money (deposits at local banks and coin and currency in their vaults) with other local banks that had balances due from banks located in financial centers.[5]

[5] For analysis of the markets for domestic exchange, see Phillips and Cutler (1998) and Garbade and Silber (1979).

This system for interregional payments—use of drafts drawn upon banks in financial centers—changed around 1890. At that time it became more common for bank customers to make payments to parties located outside of their communities with checks drawn upon their local banks (Preston, 1920, p. 566, and Jones, 1931, pp. 172-73). One way to date the use of checks for interregional payments is to examine the dates of actions by banks located in major financial centers to deal with the task of collecting checks drawn on banks located outside of the financial centers. Spahr (1926, pp. 119-30) lists a series of proposals and actions by banks to collect out-of-town checks, beginning in 1885. Major developments included the plans of the clearing houses in New York and Boston, each initiated in 1899, to deal with the collection of out-of-town checks (Cannon, 1910, and Hallock, 1903).

Methods of Collecting Checks

The growth in check transactions required a system for clearing a large number of checks among thousands of banks.[6] Checks drawn upon local banks were channeled through local clearing houses or delivered for payment directly to the issuers'' banks. Banking law required banks to pay at par on checks presented at their place of business. Typically, banks collected local checks quickly and at par.

Collecting checks involved more time and expense when the collecting and paying banks were located in different communities. The nature of banking

[6] For more details on the history of check collection practices and the effects of Reserve Bank payment services, see Jessup (1967), Magee (1923) and Preston (1920).

law contributed to the time and expense of interregional check collection. While banking law required banks to pay at par on checks presented at their place of business, banks were permitted to pay less than par on checks presented to them by mail or other indirect means. The rationale for this deduction from the face amount, called an exchange charge, was that paying banks could incur certain expenses in remitting payments to out-of-town collecting banks, including the cost of transporting coin or bank notes to the collecting banks. When the staff of collecting banks or their agents presented checks at the place of business of paying banks, in contrast, they assumed the expense of taking the cash to the collecting banks.

Delays were another expense of collecting banks, in addition to exchange charges. Under banking law, a paying bank that received checks through the mail became the collecting agent for the bank that had sent the checks. The paying bank was therefore responsible for obtaining payment from itself. As a result, paying banks often remitted funds to collecting banks several days after receiving checks through the mail.

Collecting banks that mailed checks directly to the paying banks might have to absorb any exchange charges. Under banking law depositors could charge their banks with negligence in their collection practices if the banks attempted to impose on their depositors the exchange charges incurred because the banks mailed checks to the paying banks (Spahr, 1926, p. 104).

Collecting banks attempted to minimize delays, exchange charges and charges of negligence by collecting through correspondent banks the checks they

received which were drawn upon banks located outside their communities. Correspondent banks are defined as those that collect checks for other banks. Respondent banks send checks to correspondents for collection. The depository bank is the bank where a check was first deposited in the collection process. The check is drawn on the paying bank. A collecting bank holds the check at some point in the collection process and attempts to collect from the paying bank either directly or though its agents.

Correspondent banks competed for the business of collecting checks. In attempting to give collecting banks the best terms (quickest collection at the lowest exchange charges), the correspondents developed methods to limit the exchange charges imposed by paying banks. Correspondents developed networks of banks that acted as their agents in presenting checks at the place of business of banks that set relatively high exchange charges. In collecting through correspondents and their agents, depository banks might receive less than the face amount of checks, but more than if the checks were sent directly to the paying banks through the mail. Also, depositors of the collecting banks would not have legal grounds for accusing them of negligence in their collection practices.

The process of collecting checks through correspondents as a means of avoiding exchange charges led to some notorious cases of checks passing through the offices of many banks and traveling over very long distances, relative to the actual distances between the depository banks and the paying banks. Correspondent banks attempted to bring order and efficiency to the collection process. Some correspondents announced arrangements under which they would

collect at par checks drawn upon lists of specific paying banks. Correspondents negotiated various arrangements with the paying banks on their par lists. In some cases, the respondents paid their correspondents at par for checks sent by the correspondents that were drawn upon accounts of their depositors. In addition, the respondents often served as agents for their correspondents in obtaining collection at par from other banks in their communities (Vest, 1940, p. 90). Other correspondents, in contrast, offered to pay exchange charges to respondents on checks that the correspondents sent to them for collection, while the correspondents credited the accounts of respondents at par for checks sent by the respondents for collection. The respondents paid for this service by maintaining balances at the correspondents (Tippetts, 1929, pp. 258-59). Some banks located outside of financial centers maintained balances with several correspondents in major cities so they would receive exchange charges on almost all of the checks presented to them by out-of-town banks (Willis, 1951, pp. 7-9).

The prohibition of nationwide branch banking limited the ability of correspondent banks to bring order and efficiency to the collection process. The large number of banks and the complexity of correspondent banking relationships limited the degree to which correspondent banks could economize on the operating expenses associated with check collection and the interbank balances necessary for check collection. A depository bank or its correspondent had to maintain lists of paying banks for which correspondents provided par collection and route checks to the appropriate correspondents. Unless the correspondents of the depository and paying banks maintained balances with each other, a check

would pass through other intermediaries with which these correspondents maintained accounts. A check might pass through several banks in the collection process from the depository to the paying bank. Thus, the arrangements for collection of interregional checks through correspondents encouraged the indirect routing of checks and forced a complex matrix of interbank balances to facilitate the collection system.[7]

LEGAL FOUNDATION FOR THE COLLECTION SERVICES OF THE RESERVE BANKS

Development of the Fed's role in the payments system was shaped largely by acts of Congress and litigation. The Federal Reserve Act (FRA) as enacted in 1913 did not state clearly the intent of Congress for the Fed's role in the payments system. Section 13 authorizes the Reserve Banks to receive checks from any of their member banks drawn upon other member banks. Section 16 states that Reserve Banks shall receive checks from member banks at par and authorizes the Board of Governors to establish a clearing house for the clearing of checks and drafts among the Reserve Banks. From the founding of the Fed, the Board of

[7] Weinberg (1997, p. 39) argued that the circuitous routing of checks prior to the formation of the Fed did not necessarily indicate that the check collection networks operated by correspondents were inefficient. While these networks may have been efficient under the existing constraints on bank behavior and legal relationships between collecting and paying banks, such an argument does not necessarily imply that the collection system could not be made more efficient through changes in regulations (such as permission for nationwide branch banking), reform of the legal foundation for check clearing, or government provision of clearing services.

Governors interpreted the FRA as granting the Fed a mandate to promote a national par collection system for checks.[8]

In the early years of the Fed's collection system, the Reserve Banks accepted for collection checks drawn upon all banks, including those that had not agreed to pay the Fed at par. The Reserve Banks used a variety of methods to collect at par from these nonpar banks, including hiring express agents to travel to the offices of the nonpar banks, present checks over the counter, and return with the funds. Some of the nonpar banks interpreted the Fed's collection practices as attempts to harass them into agreeing to pay the Fed at par.[9]

Nonpar banks challenged the Fed's collection practices in the courts, leading eventually to a decision by the Supreme Court of the United States in 1923. The Court ruled that since Congress did not require the Fed to establish a national system of par collection for checks, the Reserve Banks could not compel nonmember banks to pay them at par. In response to this ruling, the Reserve Banks began refusing to accept for collection checks drawn upon nonpar banks. Banks had to collect checks drawn upon nonpar banks through channels other than the Reserve Banks.

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[8] Stevens (1996) argued that the founders of the Federal Reserve system did not see a need for participation of the Fed in check collection to improve the efficiency of the payments system. Instead, Stevens argued that the founders of the Fed considered the payment services of the Reserve Banks to have a different purpose: to serve as a kind of "glue" that tied the member banks to the Fed and gave them some use for the reserve balances they were required to hold at the Reserve Banks. If the legislative history by Stevens is valid, there was a sharp contrast between the views of the Board and the people who Stevens identified as the founders of the Fed on the mission of the Fed in offering check collection services.

[9] See Harding (1920) for the response of the Federal Reserve Board to accusations by nonpar banks about the Fed s check collection practices.

RECORD OF THE RESERVE BANKS IN PROVIDING PAYMENT SERVICES

Chronology of Events

The Reserve Banks, which were established on various dates in 1914, began providing check clearing services in 1915. The Board of Governors initially pursued what it called a voluntary collection system. The Reserve Banks would receive for collection only those checks drawn upon banks that volunteered to join the Fed's collection system. Banks that joined agreed to pay at par for checks presented by the Fed for collection, even if the Fed sent the checks to the paying banks through the postal service.

Only about one-fourth of member banks joined the voluntary collection system. In its annual report for 1916, the Board expressed regret that the voluntary system had not been more successful, concluding that the voluntary plan would never achieve its objective of a universal par collection system for the U.S. economy.

To promote this objective, the Board decided in April 1916 to change its collection plan from voluntary to compulsory for member banks. Under this new plan the Fed required each member to remit at par for checks the Reserve Banks presented for collection, including checks sent through the mail. Member banks were not, however, required to send checks to the Reserve Banks for collection. The Board also adopted a policy of charging banks for the collection service: each

Reserve Bank charged the depositing bank a fee per check which reflected its check collection expenses, initially ranging from 0.9 cents to 2 cents per check.

Shortly after the Reserve Banks began offering check clearing services in the cities of their head offices, they began opening branches in other cities that also provided these services. At year end 1917, the Reserve Banks operated branches in six cities. By 1918, branches were authorized or in operation in 17 cities, and by 1920, in 22 cities located throughout the nation. The Federal Reserve System was the only nationwide banking organization, operating through this network of head offices and branches.

When the Fed established its compulsory clearing system in 1916, member banks accounted for 29 percent of all commercial banks but 50 percent of all deposits (June call report data). Thus, in terms of deposits, the authority to present checks to paying banks without exchange charges covered a large share of the banking industry.[10] Legislation in some states made Federal Reserve membership illegal or very expensive for state banks. As of June 1916, only 34 of the 18,645 state banks were Fed members. Fed membership by state banks rose rapidly after an amendment to the FRA in 1917 removed these legal obstacles that had been based on state legislation. Fed membership was concentrated among the

[10] A broader measure of the authority of the Reserve Banks to present checks to banks without paying exchange charges would include the deposits of the nonmember banks that were classified as par banks. Prior to the Supreme Court ruling in 1923 on litigation by nonpar banks, however, many of the banks that the Fed officially classified as par banks had not agreed to pay the Fed at par. In many cases the Reserve Banks put nonmember banks on their par lists if the Reserve Banks had arrangements to present checks at the place of business of these nonmember banks, even if the banks protested this practice by the Fed. Because of the controversy about which banks should have been on the par list, this section describes the size of the Fed s collection system in terms of the deposits of the member banks.

relatively large state banks. By 1920, the number of state member banks had risen to 1,373, out of 21,062 state banks (6.5 percent), but the state members accounted for 43.5 percent of the deposits of all state banks. As of June 1920, member banks accounted for 70.3 percent of the deposits of all banks (Board of Governors, 1943, pp. 16 and 17).

In 1918 the Fed began operation of its leased wire system for transfers of reserves among banks. Also, in July 1918 the Board ended the policy of charging fees to banks that deposited checks with the Reserve Banks for collection. The objective for dropping the fees was to promote use of the Fed's collection system. For the nonmember banks that agreed to pay the Fed at par, the Fed began absorbing the expenses they incurred in remitting payment to the Reserve Banks. One objective of this offer to nonmembers was to eliminate the argument that they could not remit at par because of the expenses they would incur in remitting payment.

Volumes of Reserve Bank Payment Services

The Reserve Banks very quickly became major processors of checks. Table 1 presents the number of checks cleared by the Reserve Banks and the dollar value of these checks relative to that cleared through the private clearing houses. In the period around the formation of the Fed, data were available on the dollar value of checks cleared through about 200 clearing houses in cities around the nation, which included the major financial centers and many relatively small cities. While this series does not reflect the dollar value of all checks, it provides

the broadest measure available of check clearings outside the Federal Reserve System.[11]

The volume of checks processed by the Fed's clearing system rose rapidly after the Fed adopted its compulsory plan in 1916, rising to about 33 percent of the clearings through the private clearing houses in 1918. Table 1 indicates that clearings through the Reserve Banks as a percentage of clearings through private clearing houses continued to rise through 1934.[12]

The Federal Reserve had two advantages over private correspondents in the clearing of interregional checks. One advantage was the Fed's authority to mail checks to member banks and receive payment at par (Jones 1931, p. 138). The other advantage was authority to establish offices throughout the nation. With its network of offices, the Fed could route checks to its offices closest to the paying banks, rather than relying on a network of correspondent banks to move checks from collecting banks to paying banks.

THEORETICAL FOUNDATION

Analysis of whether Reserve Bank services improved the efficiency of the check collection system requires a theoretical framework for defining and

[11] See Garvy (1959) for a description of the data on check clearings.

[12] The sharp rise in the Fed's market share after 1929 may reflect a flight to safety by respondent banks during the banking panics of the early 1930s. That is, respondent banks considered clearing checks through the Reserve Banks less risky than clearing through private correspondents. Respondent banks also behaved in this way during the 1980s; the Federal Reserve Bank of Dallas had a sharp rise in its check clearings during the Texas banking crisis (Clair, Kolson and Robinson, 1995).

measuring efficiency. This framework must indicate how the Fed could possibly have improved efficiency of the check collection business, and indicate the type of data that would be relevant for testing the hypothesis that Reserve Bank services improved the efficiency of the check collection system.

Definition of Efficiency

The definition of efficiency focuses on the costs of banks, the main providers of payment services. The payments system operates more efficiently if banks can collect the same checks at lower cost. There are two categories of cost: operating costs, which absorb resources, and the opportunity cost to banks of holding cash. If banks can collect the same checks with lower operating costs or less cash, the payments system is more efficient.[13]

Why might Reserve Bank collection services make the check collection system more efficient? Part of the answer is that Reserve Bank services may have facilitated quicker collection of interregional checks. Collection of an interregional check prior to the formation of the Fed involved routing the check through a series of correspondents and their agents in the process of getting it

[13] This definition of efficiency abstracts for the effects of Reserve Bank services on the nature of payment instruments used in the economy, and the relative efficiency of different payment instruments. In contrast, Phillips (1998) argued that the Fed s services made the payments system less efficient by encouraging bank customers to make interregional payments with checks rather than drafts. People who made payments with drafts had incentives for rapid collection, since they had already paid their banks for the drafts. People who made payments with checks drawn upon their own transactions accounts, in contrast, benefited from slow collection. Thus, Phillips concluded that Reserve Bank services tended to create a payments system in which payments instruments cleared more slowly, with more float. A problem with Phillips analysis is that the use of checks for interregional payments predated the formation of the Fed, although Fed services may have stimulated an even greater use of checks for interregional payments.

from the depository bank to the paying bank. A bank that used the services of its Reserve Bank for collection, in contrast, could mail an interregional check to its Reserve Bank, and the Fed would mail the check to the paying bank. If Reserve Bank services reduced the number of banks that handled a check (including the Reserve Banks among that number), the operating costs of the banking industry would decline. In addition, speeding collection would reduce the dollar amount of uncollected funds on the balance sheets of banks. Since uncollected funds are included in cash, speeding the collection of checks would tend to reduce the ratios of cash to total assets for banks.

The other reason why Reserve Bank services may have improved the efficiency of the banking system is that a correspondent bank could reduce its interbank balances by concentrating them at its Reserve Bank. The correspondent could rely on the Reserve Bank for check collection, rather than a network of other correspondents located in various cities around the nation. In addition, since the correspondent that relied on Reserve Bank collection services could operate with lower cash balances, competition would force it to reduce the balances it required of its respondent bank customers.

Simulations

This section illustrates the effects of Reserve Bank collection services on the operation of the payments system through simulations of check collection. One simulation is designed to reflect the nature of the check collection process prior to the formation of the Fed, and the other simulation reflects the collection

of checks through a Reserve Bank. The objective of the simulations is to illustrate the mechanisms through which Reserve Bank collection services would improve the efficiency of the payments system. Banks in the simulations hold deposits with each other for purposes of check collection; the process of check collection generates debits and credits to these interbank balances. The simulations generate the amount of cash necessary for check clearing by recording these debits and credits.

The simulations involve a given number of banks that collect checks drawn upon each other. To illustrate the nature of the simulations, consider the ten banks in Figure 1, located along a straight line. At the beginning of each day, a customer of each bank deposits a check for $100 drawn upon one of the other banks. Identities of the banks on which the checks are drawn are determined at random.

Under the most direct method of collection, staff of a collecting bank present the check to the paying bank. Distances between banks limit this option to banks located adjacent to each other. The adjacent banks maintain demand balances with each other and present checks to each other the same day their customers deposit the checks. Paying banks credit the demand balances of adjacent collecting banks the same day the collecting banks receive the checks.

To illustrate check collection by adjacent banks, suppose on the first day of the simulation Bank 1 receives a check for $100 drawn upon Bank 2. Bank 1

will present the check to Bank 2 during the day, and Bank 2 will credit the demand account of Bank 1 on day 1 for $100.[14]

The simulation exercises calculate the number of banks that process each check and the number of days each check is in the process of collection. Averages for these numbers are used as measures of payments system efficiency: the payments system is more efficient if the average number of banks that handle a check is lower, and if the average number of days a check is in the collection process is shorter. In the illustration of Bank 1 receiving a check drawn on Bank 2, the check is handled by two banks and is in the collection process for one day.

A simulation called **Collection through Correspondents** is designed to reflect the method of collecting out-of-town checks that was common prior to the formation of the Fed. Each bank designates one of the other banks in the simulation as its correspondent. Banks presents checks directly to adjacent banks for collection the same day they receive the checks, and mail other checks to its correspondent for collection. In addition, each bank agrees to pay at par on checks mailed to them by their correspondents. The postal service delivers checks

[14] In each simulation, the collected funds in interbank balances are netted bilaterally in the calculation of cash necessary for collecting checks. To illustrate bilateral netting, suppose on a given day in a simulation Bank 1 has $100 due from Bank 2, and Bank 2 has $200 due from Bank 1. After bilateral netting, Bank 1 has zero due from Bank 2, and Bank 2 has $100 due from Bank 1. Uncollected funds are not included in the bilateral netting. To illustrate, suppose that on day 1, Bank 3 receives a check for $100 drawn upon Bank 8, and Bank 8 receives a check for $100 drawn upon Bank 3. As of the end of day 1, each check is recorded as $100 of cash items in the process of collection (CIPC) held by each bank. These offsetting amounts would be netted only after the checks are presented to the paying banks for collection and credited to the interbank balances.

one day after they are mailed. Collecting banks are assumed to route checks to paying banks through channels that achieve collection at par.

Banks use the following principles in choosing their correspondents:

- Paying banks prefer to delay the presentment of checks by their correspondents as long as possible. Therefore, banks do not choose adjacent banks as correspondents, since adjacent banks could present checks for payment the same day they receive the checks.

- Banks are in more direct competition for customers with the banks adjacent to them than they are with banks located farther way. Since correspondents can learn a great deal about the operations of their respondents, a bank will not use the same correspondent as a bank located adjacent to it. The bank would not want one of its most direct competitors to gain an advantage through information disclosed by a common correspondent.

- Each respondent wants its correspondent to collect checks as quickly as possible. Therefore, each bank will want its correspondent to be located between two banks so the correspondent can present checks directly to two banks the same day it receives checks drawn on these banks. This principle rules out Banks 1 and 10 as correspondents.

- Among the correspondents that meet these criteria, respondent banks will choose the correspondents closest to them, so they can deal with any operational problems at minimum cost.

Each simulation involves the collection of checks among ten banks. Effects of Reserve Bank collection services on measures of payments system efficiency are less pronounced in simulations with six or eight banks because the smaller the number of banks in a simulation, the higher the percentage of checks that are cleared by presenting them to adjacent banks. With ten banks, several combinations of respondents and correspondents satisfy these four criteria, but the results vary little among the possible combinations. One of the combinations of

correspondents and respondents that satisfies these four criteria was selected arbitrarily.

In some cases a bank could reduce the number of days a check was in the process of collection by collecting through routes other than sending to their correspondents all checks not drawn upon adjacent banks. For instance, if a check is drawn on a bank next to an adjacent bank, a collecting bank could send a check to an adjacent bank on day 1, and the adjacent bank could present the check to the paying bank on day 2. In some cases, a collecting bank could reduce the time a check is in the collection process by one or two days by using such alternative routes for getting checks to the paying banks. The simulation of Collection through Correspondents is designed to incorporate alternative collection channels that reduce the number of days a check is in the collection process. Incorporating these alternative collection channels, which makes programming the simulation rather complex, has the flavor of the check collection process prior to the formation of the Fed as described in contemporary banking literature. If banks attempted to collect checks as quickly as possible, each check became a special project for the banker in discovering the quickest route to collection among available alternatives.

The process of check collection through correspondents is illustrated for a check that Bank 1 received on day 1, drawn upon Bank 10. The correspondent of Bank 1 is Bank 3, and the correspondent of Bank 10 is Bank 8. On day 1, Bank 1 mails the check to its correspondent, Bank 3. On the balance sheet of Bank 1, the $100 face value of the check is recorded as CIPC. Bank 3 receives the check on

day 2 and mails it to Bank 8. Each bank designated as a correspondent maintains a demand account at each of the other correspondents. As of the close of business day 2, both Banks 1 and 3 record the value of the check on their balance sheets as CIPC. The check arrives at Bank 8 on day 3, and Bank 8 mails the check to Bank 10. As of the close of business on day 3, Banks 1, 3 and 8 record the value of the check on their balance sheets as CIPC. The check arrives at Bank 10 on day 4. Bank 8 debits the account of Bank 10 for $100. Bank 1 records the value of the check as a collected balance of $100 at Bank 3, and Bank 3 records it as a collected balance of $100 at Bank 8. The check is handled by four banks and is in the collection process for four days.

Since the identity of the banks on which checks are drawn is determined at random, a respondent bank may have a negative balance at its correspondent on some days. The collected balance of the respondent generated by sending checks to the correspondent would fall short of the value of checks that the correspondent has charged against the account of the respondent. A negative collected balance would be a loan by the correspondent to the respondent. In this simulation, such negative balances are not permitted, since the objective of the simulation is to determine the cash balances that a bank would need for check collection. Cash required for check collection without negative balances is determined as follows. The simulation is run, the largest negative collected balance of each bank at its correspondent is determined, and the absolute value of that largest negative balance is added to the deposit at the correspondent each day.

The other simulation involves **Collection through a Reserve Bank**. The Reserve Bank is located at the middle of the line on which the banks are located, between Banks 5 and 6. Each bank maintains a reserve account at the Reserve Bank and collects checks through the Reserve Bank. Banks located on either side of the Reserve Bank deliver checks there the same day they receive the checks. The other banks mail checks to the Reserve Bank that are not drawn on the banks adjacent to them. The Fed delivers checks drawn on Banks 5 and 6 to these banks the same day the Fed receives the checks in the mail, debiting the reserve balances of Banks 5 and 6 the same day. The Fed mails checks to other banks the same day it receives them, and the postal service delivers the checks to the paying banks the following day. The Fed debits the reserve accounts of paying banks, and credits the reserve accounts of collecting banks, the day the checks are delivered to the paying banks, as in the accounting system of deferred availability that the Reserve Banks adopted in 1916.

To illustrate the timing of entries in Collection through a Reserve Bank, consider the following case. On day 1, Bank 1 receives a check for $100 drawn on Bank 10. Bank 1 mails the check to the Reserve Bank on day 1; the Reserve Bank receives the check from the postal service on day 2 and mails the check to Bank 10, where it arrives on day 3. On days 1 and 2, Bank 1 has CIPC of $100. On day 3 the Reserve Bank credits the reserve account of Bank 1 for $100 and debits the reserve account of Bank 10 for $100. Three banks handle this check: Bank 1, the Reserve Bank, and Bank 10. The check is in the collection process for three days.

Simulation of Collection through a Reserve Bank can generate negative collected balances of banks at the Reserve Bank. After running the simulation, the absolute value of the largest overdraft is added to the reserve balance of the bank each day, to avoid overdrafts of reserve accounts.

Table 2 presents the results of simulations of check collection through correspondents and through a Reserve Bank. In each simulation, a bank receives one check each day drawn upon other banks, for 20 days. The banks on which the checks are drawn are determined at random. Banks collect the same 20 checks following the procedures under both arrangements for check collection. The process of selecting 20 checks at random and running the collection programs was done five times. Results in table 2 reflect the distribution of results across five sets of 20 checks each.

In the simulation of collection through correspondents, the average number of banks that handled a check across the five sets of checks is 2.96 banks, compared to 2.82 banks for collection through a Reserve Bank, or 5 percent higher for collection through correspondents. For each of the five sets of checks to collect, this number is higher for the simulation of collection through correspondents than for the simulation of collection through a Reserve Bank. These simulation results illustrate the basis for lower operating costs of banks under check collection through Reserve Banks.

The simulation results indicate that it takes longer on average to collect a check through correspondents than through a Reserve Bank. The average length of time a check was in the collection process was 2.49 days for collection through

correspondents, compared with 2.27 days under collection through a Reserve Bank, or about 10 percent higher for collection through correspondents. The cash required for collection of checks through correspondents is about 36 percent higher than the cash required for collection through a Reserve Bank.[15]

Testable Hypotheses

The theoretical foundation in this section yields three testable hypotheses: First, development of the Fed's check collection system would tend to reduce the operating costs of the banking industry. Second, development of the Fed's collection system would permit banks to operate with lower ratios of cash to total assets. Third, when banks had a choice of using the Fed's collection system or the payments arrangements in use prior to the formation of the Fed, they would choose the Fed's services.

[15] A possible concern about the simulations is that some of the cash necessary for check collection under Collection through Correspondents appears on the balance sheet of the Reserve Bank but is not counted as part of bank cash in the simulation of Collection through a Reserve Bank. The Reserve Bank has CIPC among its assets on the days when it receives checks for collection and mails them to the paying banks. Under the simulation of Collection through Correspondents, this CIPC is on the books of the correspondents. Thus, the results in table 3 may exaggerate the amount by which the banking system could reduce it cash holdings by shifting check collection from correspondents to a Reserve Bank. To deal with this concern, the average CIPC on the books of the Reserve Bank could be added to the cash of banks under the simulation of Collection through a Reserve Bank. This adjustment has a small effect on the comparison of the simulations: table 3 reports that cash is 36 percent higher under Collection through Correspondents than under Collection through a Reserve Bank, whereas cash is 32 percent higher under Collection through Correspondents if the average CIPC of the Reserve Bank is added to cash in the simulation of Collection through a Reserve Bank.

THE EVIDENCE

The theory section indicates that evidence of a positive effect of Reserve Bank collection services on payments system efficiency would be a reduction in the operating expenses of the banking industry. Unfortunately, data on bank costs around the time when the Fed developed its payment services are not sufficiently detailed for a test of this hypothesis. This section examines two types of evidence on whether the Fed's payment services improved the efficiency of the payments system. The first type of evidence is the rapid acceptance by banks of the Fed's check clearing services over the alternative arrangements for interregional collection that were available prior to the formation of the Fed. The second type of evidence is reductions in the cash ratios of banks that can be attributed to the Fed's payment services.

Banks Chose to use Reserve Bank Check Collection Services

The timing of growth in the Fed's collection system is consistent with the view that the Reserve Banks satisfied a demand for more efficient interregional check collection that had been unmet prior to the formation of the Fed. In 1915 the dollar value of checks cleared by the Fed was only about 3 percent of the dollar value of checks cleared through the private clearing houses. Lack of success of the Fed's collection system in 1915 seems to be related to its voluntary nature that year. Under the voluntary system, member banks did not have to join

the Fed's collection system. If they joined, however, they had to agree to pay at par when the Fed presented checks.

The limited response by banks to this offer reflects the nature of the payments system as a network good. Demand for a good exhibits network effects if demand by an individual customer depends on the number of other customers who use the good.[16] While many banks might have viewed a par collection system as valuable in principle, the value of such a system to each bank would depend on the number of other banks that agreed to join. When only a small percentage of banks agreed to pay the Fed at par, others had limited interest in joining. Why should they forgo some of their revenue from exchange charges if the new collection system could make par presentment to only a small percentage of banks?

The Fed changed its collection system substantially in 1916: all member banks were required to pay at par for checks presented by the Fed, and the Reserve Banks began charging collecting banks fees to cover the collection expenses of the Reserve Banks. The volume of check clearing through the Reserve Banks began growing rapidly immediately after these changes in the collection system.

The timing of growth in the Fed's check collection operations does not support the hypothesis that the Reserve Banks gained a large share of the nation's check collection business by subsidizing their collection operations. The Fed's collection system had already grown to a relatively large share of national check

[16] For analysis of network effects, see Katz and Shapiro (1994) and Economides and White (1994).

collection by the time the Fed stopped charging depositing banks collection fees in 1918. The Fed's share continued to rise after 1918, but at a slower pace than in the period from 1915 to 1918. The most important action to stimulate growth of its collection system appears to have been the Fed's decision to require all member banks to pay at par for checks presented by the Reserve Banks.

Cash Assets of the Banking Industry

An important challenge in assessing the effects of the Fed's collection services on the cash held by banks involves the effects of changes in reserve requirements. The FRA reduced substantially the reserve requirements of national banks, which were required to be Fed members.[17] In addition, about half of the states reduced their reserve requirements around the time the Fed was founded (see White, 1983; and Gilbert, 1998). This division creates a type of experiment: if the cash ratios of state banks declined around the time the Fed developed its payment services, were the declines limited to banks in states that reduced their reserve requirements?

Before examining the evidence on cash ratios, it is appropriate to consider the mechanisms through which Reserve Bank check clearing services might have affected the cash ratios of state banks. Only a small percentage of state banks were Fed members, especially during the early years of the Reserve Bank clearing

[17] The Comptroller of the Currency (1915) calculated the reductions in required reserves for national banks as follows: 28 percent for national banks located in central reserve cities, 41 percent for banks in reserve cities, and 26 percent for national banks located elsewhere. In addition, there was a reduction in required reserve ratios for Fed members in 1917.

system. The state banks that did join the Fed, however, were relatively large. As early as June 1918, about 35 percent of deposits at state banks were at state members, and by June 1924, the share at state members was over 50 percent. State banks that were not Fed members may have benefited from Reserve Bank collection services indirectly. If their correspondents sent interregional checks to the Fed for collection, faster collection of interregional checks through the Reserve Bank collection system would have reduced the amount of uncollected funds in the accounts of nonmember banks at their correspondents. The simulation of Collection through Correspondents presented above illustrates how the speed of collection by correspondents affects the uncollected funds of their respondents. In addition, if Reserve Bank collection services permitted correspondent banks to reduce the shares of their assets held as collected interbank balances, competition would have forced correspondents to reduce the levels of collected balances they required of their respondent bank customers as compensation for check clearing services.

Figure 2 presents the ratios of cash to total assets for national and state banks in the states that did not reduce their reserve requirements in the years 1913 through 1925. Cash ratios of national and state banks declined sharply around the time the Fed was founded. Because of reductions in reserve requirements, it is not possible to attribute the reductions in cash ratios of national banks to the operation of the Fed's collection system.[18] Changes in reserve requirements, however, do

[18] The numerator of the cash ratio includes the value of vault cash, balances with other banks and CIPC. The denominator is total assets. Since banks held cash primarily to serve their

not complicate the interpretation of the cash ratio of these state banks. Their cash ratio declined about five to six percentage points during the period of rapid growth in the Fed's check collection system, and the cash ratio of these banks remained at a new lower level throughout the 1920s. This pattern of change in the cash ratios of state banks in Figure 2 is similar to the pattern for banks in states that lowered their reserve requirements.

Another factor that might have influenced the cash ratios of banks around the time that the Fed developed its collection service was the financing of the First World War. State banks in the U.S. increased their holdings of U.S. government securities substantially during the war, from less than half of one percent of total assets in 1916 about nine percent in 1918. With more liquid assets that served as "secondary reserves," banks may have been comfortable operating with lower cash ratios than before. The ratio of U.S. government securities to total assets declined after 1918, however, falling to around six percent by 1929. If the securities holdings of banks explained their declines in cash ratios after 1916, we would expect the cash ratio to rise again after 1918, which did not happen. Thus, the financing of the First World War does not appear to explain the pattern of the decline of cash ratios around the time the Fed developed its collection system.

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customers who made payments out of demand deposits, a more ideal ratio might be cash to demand deposits. Data on the deposit liabilities of banks for the period covered in Figure 2 were of relatively poor quality, especially the division of deposits between demand and other deposits. See Board of Governors (1959). For this reason, cash ratios in this article use total assets as the denominator.

Regression Analysis of Cash Ratios

While interpretation of Figure 2 provides one method of assessing the effects of Reserve Bank services on the cash ratios of banks, regression analysis is a statistical method of estimating the effects of Reserve Bank payment services, holding constant other influences on cash ratios. The dependent variable is the natural log of cash divided by total assets. Observations are limited to state banks because the complexity of changes in the reserve requirements of national banks around the time when the Fed was founded makes it difficult to derive a variable to represent the reserve requirements of national banks. The structure of state reserve requirements, in contrast, was simpler. For cash ratios there is one observation per state per year. The years are 1909-29, the period for which White (1983) presents the details of state reserve requirements. Balance sheet data for state banks are from the Board of Governors (1959).

Table 3 identifies the variables, and Table 4 presents the regression results. Values of the independent variable included to reflect the development of the Fed's collection system (FEDSHARE) are presented in the last column of Table 1: the value of checks collected through the Reserve Banks as a percentage of the value of checks cleared through the clearing houses. This is a national observation, one per year. The coefficient on FEDSHARE is hypothesized to be negative: growth of the Fed's collection services permits banks to operate with lower cash ratios.

The measure of reserve requirements (REQUIRED) is derived by calculating the required reserves for state banks in each state each year, based on their reserve requirements and deposit liabilities, and dividing by their total assets. The coefficient on REQUIRED is hypothesized to be positive: banks in states with higher reserve requirements hold higher cash ratios.

Three independent variables reflect the composition of securities owned by the banks. If U.S. Treasury securities served as secondary reserves, the coefficient on US TREASURIES would be negative: an increase in the share of assets held as Treasury securities would permit banks to operate with lower cash ratios. The other securities ratios (STATE&LOCAL and OTHER) are included to test whether other types of securities served as secondary reserves.

Some additional independent variables reflect the extent of branching in a state (BRANCH) and the proximity of banking offices to each other (DENSITY). The theoretical basis for including these independent variables involves an application of inventory theory to the decisions of banks on the shares of their assets they hold as cash in their vaults. Banks hold vault cash to meet the demand of their depositors. An inventory too small would upset depositors, possibly triggering a run on the bank. Banks want to hold the minimum inventory that meets the demands of their depositors, however, because cash yields no interest. The optimal inventory of cash depends on the expenses associated with increasing and decreasing vault cash.

BRANCH, which is a measure of the degree of branch banking in a state, is calculated as the ratio of the number of banking offices in the state (offices of

state and national banks) to the number of banks. A bank with more than one office will hold an inventory of cash at each office to meet the demand of its depositors. Since the bank does not know which office will face demands for cash, it will tend to hold a higher percentage of its assets in vault cash than if it had only one office. The coefficient on BRANCH is hypothesized to be positive.

When banks need more vaults cash, they are likely to get it from their own branches or from other banks, and when they have excess vault cash, they will deposit it with other banks. Expenses associated with adjusting the size of the inventory of vault cash will be lower in areas where banking offices are located closer together. The measure of the proximity of banking offices, DENSITY, is measured as the number of banking offices in a state divided by square miles. The coefficient on DENSITY is hypothesized to be negative.

Prior to the 1930s when the federal government established deposit insurance, several states had deposit guarantee arrangements. The coefficient on INSURANCE -- a dummy variable with a value of unity for states with deposit guarantee plans, zero otherwise -- is hypothesized to be negative, since insurance may have allowed banks to operate with lower cash ratios because of less concern about depositor runs.[19]

Dummy variables for regions are included as independent variables to estimate the effects of regional influences on the cash ratios of state banks. The

[19] See Federal Deposit Insurance Corporation (1956) for details of the state systems of deposit insurance.

excluded region includes the states New Jersey, New York and Pennsylvania, which includes the nation's financial center.

The coefficient on the variable FEDSHARE is negative, as hypothesized, and statistically significant (table 4). The size of this coefficient indicates that a rise in FEDSHARE by 10 percentage points, such as a rise from 10 percent to 20 percent, reduces the cash ratio of banks by 5.4 percent. The size of this coefficient is consistent with the conclusion that Reserve Bank check collection services had positive effects on the efficiency of the payments system that were economically significant.

The coefficient on REQUIRED, which is statically significant, indicates a positive effect of reserve requirements on cash ratios. The size of the coefficient on REQUIRED implies that an increase in this variable from 0.1 to 0.11 would increase the cash ratio of state banks by 5.79 percent. The coefficients on US TREASURIES and STATE&LOCAL are not statistically significant. The negative, significant coefficient on OTHER can be interpreted as indicating that the securities which banks used as their secondary reserve of liquid assets were those issued by borrowers other than the federal, state or local governments. The size of the coefficient on OTHER implies that an increase in the ratio of other securities to total assets from 0.1 to 0.2 would reduce the ratio of cash to assets by 21.6 percent. The coefficient on BRANCH is positive and statistically significant, as hypothesized. The size of the coefficient on BRANCH implies that an increase in the ratio of banking offices to banks from 1.0 to 1.1 would increase the ratio of

cash to assets by 9.1 percent. The coefficients on DENSITY and INSURANCE are not significant.

The dummy variables for regions improve the fit of the equation. Coefficients on five of the eight regional dummy variables are statistically significant at the five- percent level. The F test on the hypothesis that the regional dummy variables as a group contribute to the explanatory power of the equation is significant at the one- percent level.

CONCLUSIONS

Histories of the Fed's payment services generally focus on the failure of the Fed to achieve its goal of getting all banks to participate in a national system for collecting checks at par. This paper uses a different standard for evaluating the Fed's payment services: effects on the efficiency of the system for collecting checks. The goal of universal par check collection remained out of reach for the Fed for several decades. Evidence from the period around the time when the Fed was founded, however, is consistent with the view that the Fed's services improved the efficiency of the system for collecting checks relative to the efficiency of that system just prior to the formation of the Fed.

Banks chose to use the Fed's check collection services rather than the payments arrangements available prior to the formation of the Fed. The share of checks cleared through the Reserve Banks rose dramatically after the Board acted in 1916 to require member banks to pay the Fed at par, despite the fee per check that each Reserve Bank began charging collecting banks in 1916. Banks found

the Fed's collection system more attractive than the prior system of collecting interregional checks through correspondents. Growth in the collection volume of the Reserve Banks indicates that a demand by banks for a national par collection service had been unmet prior to the formation of the Fed. The Reserve Banks already accounted for a large share of the nation's check collection activities in 1918 when the Fed suspended its check collection fees

Reserve Bank payment services permitted banks to operate with lower ratios of cash to total assets. For state banks in the states that did not reduce their reserve requirements around the time when the Fed was founded, ratios of cash to assets declined about five percentage points during the period of rapid development in the Fed's payment services, and then remained at the new lower level. Regression analysis indicates a significant effect of the Fed's check collection system on the cash held by state banks, holding constant the effects of reserve requirements and other influences.

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Table 1
Volume of Checks Processed by the Reserve Banks

Year	Millions of checks	Dollar value of checks (billions of dollars)	Value of checks processed by the Reserve Banks as percentage of checks cleared through clearing houses
1915	8.8	$ 4.7	2.9%
1916	25.8	10.9	4.5
1917	75.7	44.9	14.7
1918	154.4	105.7	32.9
1919	305.2	136.5	35.2
1920	452.1	156.5	35.6
1921	522.7	119.2	34.1
1922	584.9	150.5	39.1
1923	639.2	196.6	48.6
1924	684.0	209.1	46.9
1925	716.5	247.2	49.4
1926	758.5	261.4	51.0
1927	794.8	266.7	49.0
1928	818.5	289.0	46.4
1929	852.1	351.7	49.1
1930	834.2	311.2	57.2
1931	796.9	237.8	57.8
1932	677.0	169.2	65.4
1933	635.0	151.2	62.0
1934	754.7	171.9	65.1

Sources: Observations on check clearings by the Federal Reserve Banks are from the *Annual Reports* of the Board of Governors of the Federal Reserve System. Data on the value of checks cleared through clearing houses are from U.S. Department of Commerce (1960, p. 640). The annual observations for the number of checks cleared by the Reserve Banks, and the dollar value of the checks, are adjusted to eliminate duplications in reports by the individual Reserve Banks. A duplication occurs if two Reserve Banks report the same item as one of their items handled. The Annual Reports of the Board of Governors for 1919 through 1926 provide data on items handled with and without duplications. Data for 1915-18 reported with duplications are adjusted using data for 1919, and data for the years 1927-34 are adjusted using the data for 1926.

Table 2

Simulation Results

	Collection arrangement:	
Mean (range) of measures of efficiency of checks collection across five sets of checks to collect	Collection through correspondents	Collection through a Reserve Bank
Average number of banks that handled a check	2.96 (2.89 to 3.05)	2.82 (2.79 to 2.85)
Average number of days a check was in the collection process	2.49 (2.40 to 2.59)	2.27 (2.20 to 2.35)
Cash of banks under "Collection through Correspondents" divided by cash under "Collection through a Reserve Bank"	1.3635 (1.2535 to 1.4895)	---

Table 3

Identification of Dependent and Independent Variables

Dependent Variable -- natural log of the following ratio: for the state banks in each state, the sum of their cash (vault cash, demand balances due from banks and cash items in the process of collection) and divide by the sum of their total assets.

Independent Variables

FEDSHARE -- the dollar value of checks cleared by the Reserve Banks as a percentage of the dollar value of checks cleared through the clearing houses.

REQUIRED -- the required reserves of state banks in a state (required reserve ratios multiplied by the sum of their deposit liabilities subject to reserve requirements) divided by the sum of their total assets.

US TREASURIES -- the sum of investments by state banks in securities issued by the federal government, divided by the sum of their total assets.

STATE&LOCAL -- the sum of investments by state banks in securities issued by state and local governments, divided by the sum of their total assets.

OTHER -- the sum of investments by state banks in securities other than those issued by the federal, state or local governments, divided by the sum of their total assets.

BRANCH -- a measure of the extent of branch banking in a state: the number of banking offices in the state divided by the number of banks.

DENSITY -- the number of banking offices in a state divided by the number of square miles in a state.

INSURANCE -- dummy variable with a value of unity if banks in a state were covered by deposit insurance, zero otherwise.

NE -- dummy variable with the value of unity for the states of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont, zero otherwise.

SA -- dummy variable with the value of unity for the states of Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia and West Virginia, zero otherwise.

ESC -- dummy variable with the value of unity for the states of Alabama, Kentucky, Mississippi and Tennessee, zero otherwise.

WSC -- dummy variable with the value of unity for the states of Arkansas, Louisiana, Oklahoma and Texas, zero otherwise.

ENC -- dummy variable with the value of unity for the states of Illinois, Indiana, Michigan, Ohio and Wisconsin, zero otherwise.

WNC -- dummy variable with the value of unity for the states of Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota, zero otherwise.

PN -- dummy variable with the value of unity for the states of Idaho, Montana, Oregon, Washington, and Wyoming, zero otherwise.

PS -- dummy variable with the value of unity for the states of Arizona, California, Colorado, Nevada, New Mexico and Utah, zero otherwise.

Table 4

Regression Results

Dependent variable: natural log of the ratio of cash to total assets

Independent variables	Coefficient	t-statistic
FEDSHARE	-0.0054	-7.431
REQUIRED	5.7900	9.741
US TREASURIES	-0.2327	-0.623
STATE & LOCAL	-1.1060	-1.377
OTHER	-2.1600	-9.217
BRANCH	0.9101	5.053
DENSITY	-0.0825	-1.522
INSURANCE	0.0262	0.863
NE	0.2530	3.730
SA	0.1589	4.032
ESC	-0.0230	-0.425
WSC	0.1257	2.361
ENC	-0.0190	-0.389
WNC	0.0956	2.593
PN	0.0235	0.629
PS	0.1782	4.190
Constant	-1.8960	-29.300

$\overline{R}^2 = 0.643$ $N = 1008$

F-statistic (8,991) for the hypothesis that the regional dummy variables are jointly significant: 7:153*

*Statistically significant at the five percent level.

Note: newey-West adjustment for autocorrelation and heteroskedasticity applied to the equation.